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DAO of Network Circular and Rectangular Antenna

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ABSTRACT

The estimation of the direction of arrival of signals (DOA) in two dimensions in the azimuthal plane and the elevation plane, attracting more and more interest for many applications including Radar, Radio Astronomy and Mobile Communication. This paper presents the Matrix Pencil method for DOA estimation in two dimensions for the URA configurations (Network uniform rectangular antenna) and UCA (uniform circular antenna array), then in consideration of the performance of this method.

Key words: ULA, URA, UCA, DOA, Adaptative antenna, Matrix Pencil

1. INTRODUCTION

Smart adaptive antennas seem to be a promising way to increase the capacity of transmission systems. They are able to reduce interference inherent in multipath, enhance the signal to noise ratio and bring the frequency reuse. In this research, we applied the algorithm based on the Matrix Pencil method to the so-called smart antenna systems for three configurations of rectangular linear networks and circular [1-9].

For the linear array of omnidirectional antennas, an algorithm for estimating the angle and the delay based on the Matrix Pencil method was proposed to eliminate multipath. For the rectangular array of omnidirectional antennas, we estimated the arrival by Unitary Matrix Pencil method directions. The stochastic gradient algorithm (LMS Least Mean Squares) was used to guide the radiation pattern of the antenna to the desired signal.

For the circular array, our choice fell on the circular patch antenna as a basis for its integration in smart antenna systems. DOA (Direction Of Arrival) desired and interfered signals is accurately determined with the Matrix Pencil method

2. METHOD 2-D ENHACED MATRIX PENCIL (2-D EMP) FOR A UNIFORM RECTANGULAR ARRAY OF ANTENNAS

We consider a rectangular array of () isotropic antennas evenly spaced dx and dy respectively along the axes OX and OY, where we assume dx = dy = d. The network receives signals Qs with the angles of incidence (θq, φq), which are respectively φq θq and the directions of arrival in elevation and in azimuth. The information on the arrival direction is contained in the eigenvalues of the two transformation matrices that bind respectively subnets 1 and 2 in the X direction and subnets 3 & 4 in the Y-direction [10-11]. The values of αx and αy are written in the following form:

$$\begin{cases} \alpha_{xi} = \exp\left(j\,\dfrac{2\,\pi\,\Delta}{\lambda_0}\sin\theta_i\cos\phi_i\right) \\ \alpha_{yi} = \exp\left(j\,\dfrac{2\,\pi\,\Delta}{\lambda_0}\sin\theta_i\sin\phi_i\right) \end{cases} \qquad (1)$$

$$i = 1,2,\dots,Q_s$$

The elevation and azimuth are expressed by the following equation:

$$\begin{cases} \theta_i = Arc\sin\left[\dfrac{-j\lambda_0}{2\,\pi\,\Delta}\sqrt{(Ln\,\alpha_i)^2 + (Ln\,\alpha_i)^2}\right] \\ \phi_i = Arctg\left[\dfrac{Ln\,\alpha_i}{Ln\,\alpha_i}\right] \end{cases} \qquad (2)$$

$$i = 1,2,\dots,Q_s$$

3. SIMULATIONS RESULTS FOR URA

For all simulations we assume that the noise is white gaussian variance σ2,.The distance between elements of the network Δ=Δx=Δy=λ/2. To make the comparison between the three methods the Cramér -Rao be used , the latter is a fundamental tool in probability theory , as it allows to analyze the performance of an estimator by comparing the variance of the latter to an optimum value , which takes place in some sort of reference quality . A study of the Cramér -Rao has been proposed in [12-15]. The theorem of Cramér -Rao to estimate angles of arrival for a rectangular array is defined in [14-20] . Consider two signals with the incidence angles θ = [45°,55°] and ϕ=[30°,40°], arriving on a rectangular array consisting of (N * M) isotropic antennas . The simulations are performed for a number of 800 observations and a single sample. Figures 1 and 2 show the influence of the SNR on the inverse of the variance of the estimated values of θ (elevation) and ϕ (azimuth) in the logarithmic domain for methods 2-D EMP, 2 - D MP and EMP and by varying the M and N numbers of antennas, and Pencil parameters m1 and m2.

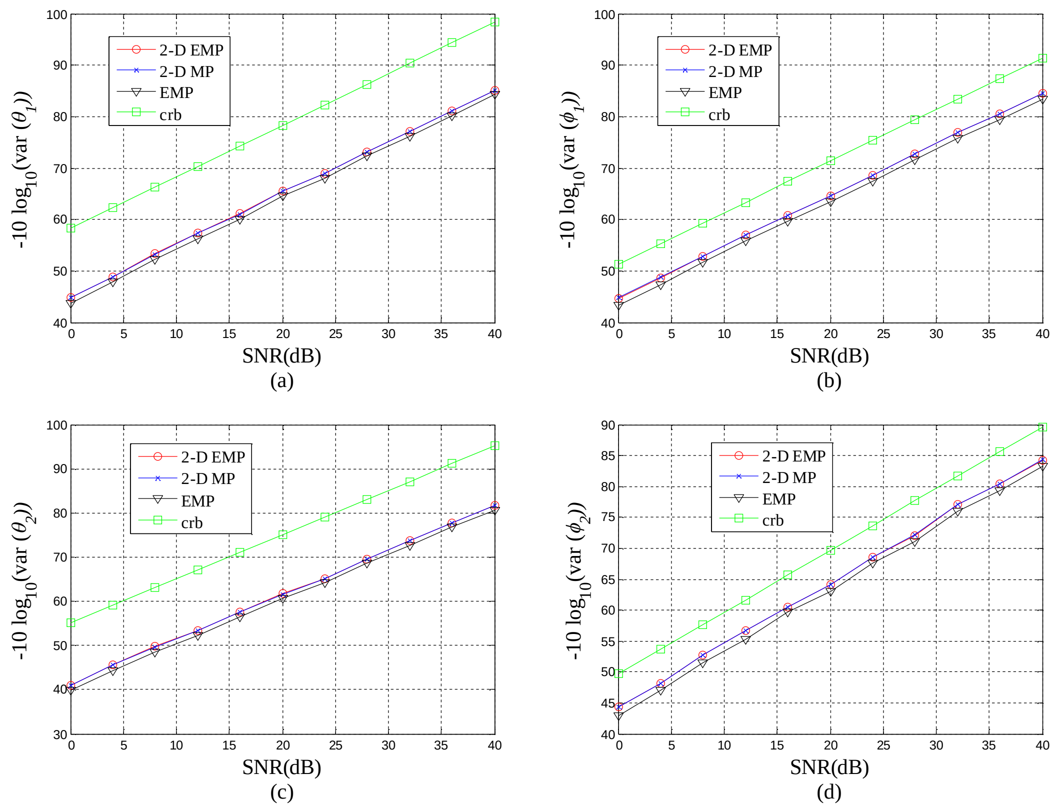


Figure 1: Inverse of the variance of the estimated SNR as a function of angles, 20*20 antennes, m_1=m_2=9

(a) Variance -10 log10 (var (θ_1)), (b) Variance -10 log10 (var (ϕ_1))

(c) Variance -10 log10 (var (θ_2)), (d) Variance -10 log10 (var (ϕ_2))

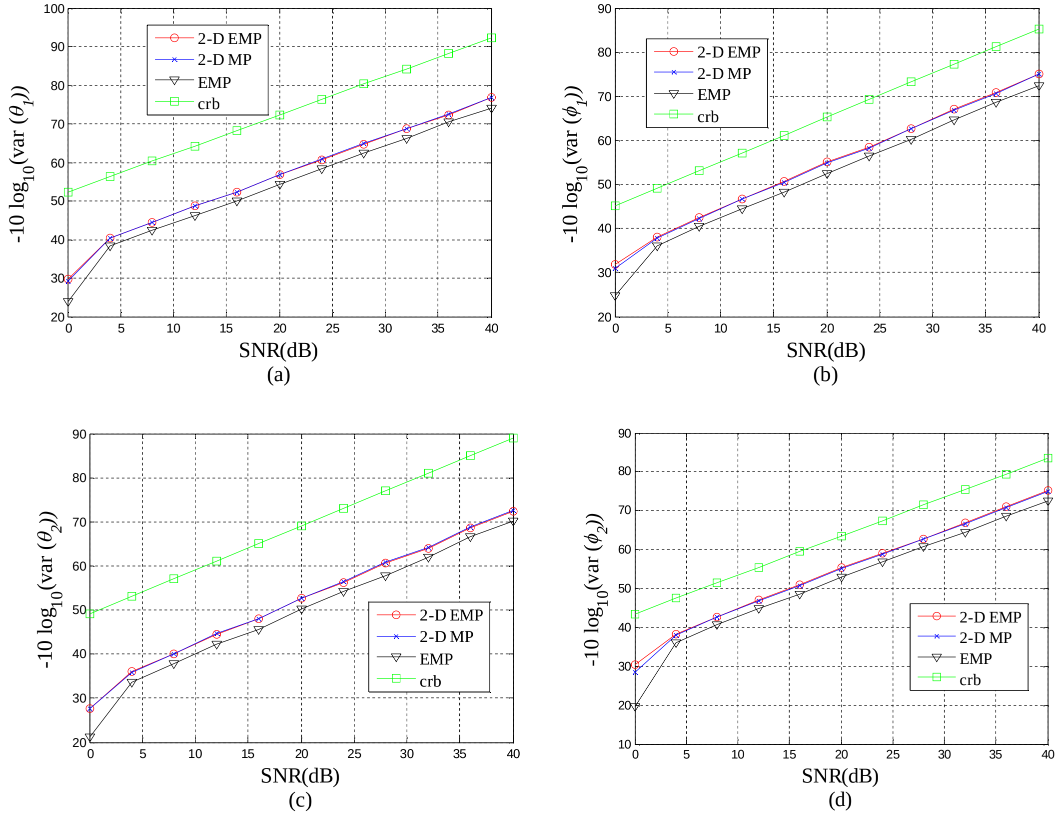
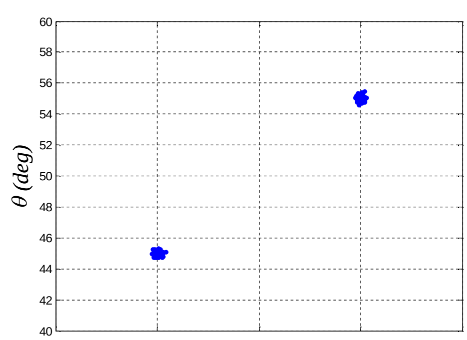


Figure 2: Inverse of the variance of the estimated SNR as a function of angles, 14 * 14 antennas, m1 = m2 = 6

(a) Variance -10 log10 (var (θ_1)), (b) Variance -10 log10 (var (ϕ_1))

(c) Variance -10 log10 (var (θ_2)), (d) Variance -10 log10 (var (ϕ_2))

Methods 2-D EMP and 2- D MP were better than those of the performance method EMP. We also note that the 2 -D EMP method is less sensitive to loud noises decreases when the number of antennas, but in general the methods 2 -D EMP and 2 -D MP have the same performance. Calculating the complexity of these three methods [3] amounts to calculating the number of operations performed by the tools most responsible for the algorithm, namely SVD, Matrix Pencil and correct coupling. For comparison of the three methods, we note that 2 -D EMP performs fewer operations. Consider two signals with the incidence angles $\theta = [45°, 55°]$ and $\phi = [30°, 40°]$, arriving over a network of size N = M = 20 . These simulations are performed for a number of 800 observations and a single sample. m1 = m2 = 9. Figures 3 and 4 show the cloud point of the estimated values of θ (elevation) and ϕ (azimuth) by method 2 – D EMP for various values of SNR.



The estimate of θ (elevation) and ϕ (azimuth) by method 2-D EMP is more accurate when the SNR increases.

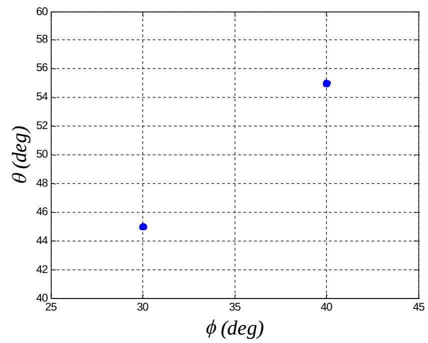


Figure 4: Cloud points of arrival directions, SNR = 15 dB, θ=[45°,55°] , ϕ=[30°,40°]

4. SIMULATIONS RESULTS FOR UCA OF UNITARY MATRIX PENCIL FOR UNIFORM RECTANGULAR ANTENNA

We consider a rectangular array of ($M \times N$) isotropic antennas. One can infer the elevation and azimuth directly without using the correct coupling, is used as Us and Vs at the same time.

$$\begin{cases} \theta_i = Arc\sin\left[\dfrac{-j\lambda_0}{2\ \pi\ \Delta}\sqrt{(Ln\,\psi_{xi})^2+(Ln\,\psi_{yi})^2}\right] \\ \varphi_i = Arctg\left[\dfrac{Ln\,\psi_{yi}}{Ln\,\psi_{xi}}\right] \end{cases} \quad (3)$$

$i = 1,2,\ldots,Q_s$

For all the simulations, it is assumed that the incident signal is contaminated with white Gaussian noise with variance σ2, its stage γi=0°. The distance between elements of the network Δ=Δx=Δy=λ/2. The Cramer-Rao band is used for performance comparison. In the previous subsection, it was shown that the 2-D EMP method has better performance, so we will compare the 2-D UEMP. Two sources are consistent with the angle of incidence θ=[45°, 55°] and ϕ = [30°, 40°], arriving on a network of size M = N = 20. The simulations are performed for a number of 800 observations and a single sample. SNR = 20 dB. Figure 6 shows the influence of the parameters m1 and m2 on the inverse of the variance of the estimated values of θ (elevation) and ϕ (azimuth) in the logarithmic domain for methods 2-D UEMP et 2-D EMP.

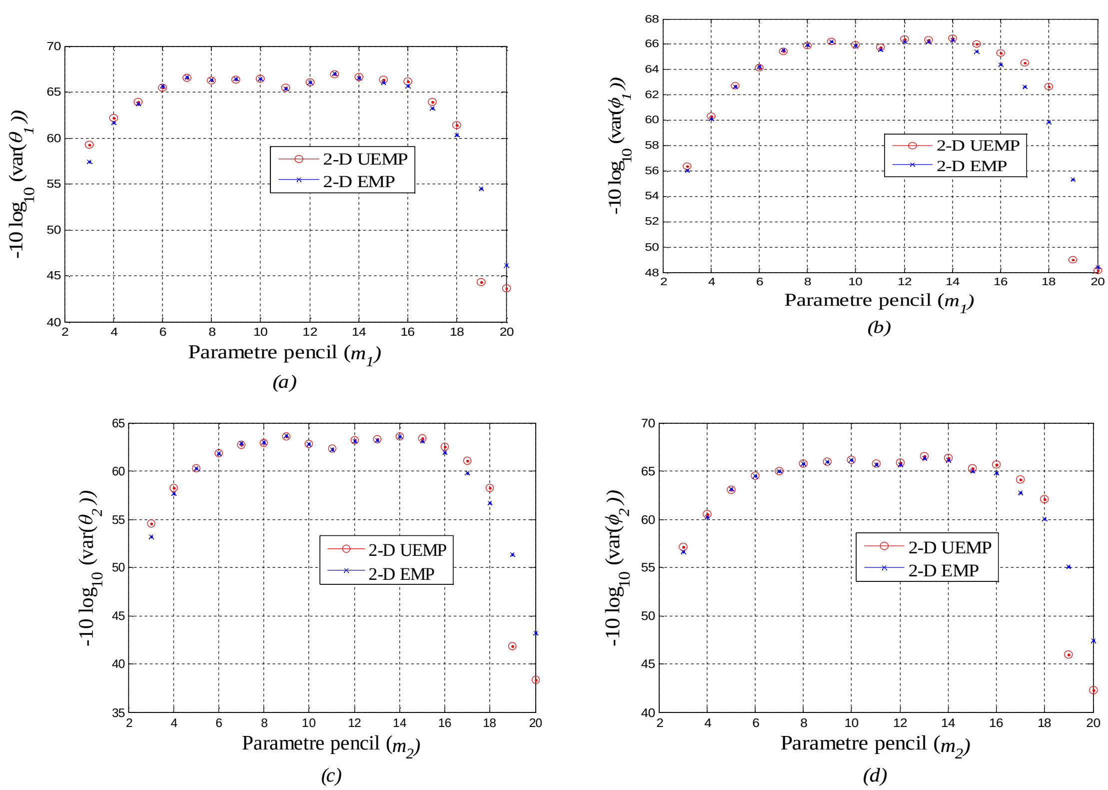


Figure 6 : Inverse of the variance of the estimated angles in function of the *Pencil parameters*
(a) Variance $-10 \log_{10}$ (var (θ_1)) in m_1 function
(b) Variance $-10 \log_{10}$ (var (ϕ_1)) in m_1 function
(c) Variance $-10 \log_{10}$ (var (θ_2)) in *m2* function
(d) Variance $-10 \log_{10}$ (var (ϕ_2)) in *m2* function

Figure 6 shows that both methods 2-D UEMP and 2-D EMP are more sensitive to noise when the Pencil parameter equals Qs and N- Qs or M-Qs. We note that the best choices are 9 and 12 m1 and m2 are those of 9 and 11. Indeed found in the literature, for a linear array, with the best choice of the parameter is such that Pencil $N/3 \leq m \leq 2N/3$. For the following simulations is taken m1 = m2 = 9 to the networks M = N = 20 and M = N = 19, and m2 = m1 = 8 for a system M = N = 18.

5. CONCLUSION

In this paper, we studied the implementation of Matrix Pencil for Both UCA and URA configurations for a single sample which allows us to work in real time. We adopted the URA network has new version of Matrix Pencil called Expired 2-D EMP. This method was compared with two other methods EMP and 2-D MP. The results showed a reduction of the computation time, the algorithm Then Applied to the Unitary method Unitary That Allows us to work with real operations, and subsequently for reduce the computation time. For the UCA network, the method based on the Matrix Pencil yielded better results than Those Obtained with ESPRIT.

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